

APPENDIX F-2

COST BENEFIT ANALYSIS SAMPLE 2

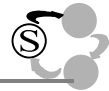
Development of a New IT System

This appendix is a sample cost benefit analysis developed as a supplement to the *Cost Benefit Analysis Guide for NIH IT Projects* has been designated a “best practices approach” by the Trail Bosses Interagency Committee.

This represents a classic Cost-Benefit Analysis prepared as part of an IT Investment Review Process. This sample illustrates a Cost-Effectiveness Analysis because the benefits are assumed to be the same for the alternatives being considered. The figures used and the organizations are totally fictional, and have no relation to any real project.

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EXECUTIVE SUMMARY

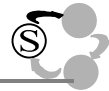
The basic objective of this project is to develop a Health Research Management Evaluation System (HRMES) that provides managers in the Department of Health (DOH) Agency for Health Research (AHR) with an administrative information system that allows them to generate reports that show the status of the organization and evaluate the effectiveness of the managers. By using performance measures that quantify progress toward accomplishing the organization's mission, the system will not only report the status of an organization in terms of dollars spent, projects completed, and personnel utilization; it will provide a quantitative evaluation of the success in achieving goals and objectives that support the mission of the organization.

The AHR managers currently use reports from systems operated at the DOH, AHR and the Bureau levels. These IT systems provide managers with a variety of reports on many different aspects of their organization, but none of them have information that can be related to indicators that measure performance of progress toward mission goals and objectives. The fact that we spent 99.99% of all appropriated funds and completed 1,000 research projects does not give us any idea whether or not the money spent and the efforts expended provide any benefits to the federal taxpayers. Compliance with the Government Performance and Results Act (GPRA) is currently being accomplished by manually comparing actual accomplishments against predetermined measures of accomplishment. Each of the 8 Bureaus use one full-time person each month to maintain and monitor the performance measures and prepare the reports.

The following table shows that the benefits will exceed the costs over the 10-year life cycle of the system. The payback period is five years, the return on the investment, identified in the table as Discounted Net, is \$1,102,103, and the return on investment (ROI) rate is 53%.

Year	Annual Cost AC	Annual Benefit AB	Discount Factor DF	Discounted Cost (DC) ACxDF	Discounted Benefit (DB) ABxDF	Discounted Net DB-DC	Cumulative Discounted Net
1	270,137		0.9825	265,402	0	(265,402)	(265,402)
2	462,040		0.9483	438,167	0	(438,167)	(703,569)
3	214,080	492,232	0.9154	195,964	450,579	254,614	(448,954)
4	214,080	492,232	0.8836	189,155	434,921	245,767	(203,188)
5	214,080	492,232	0.8529	182,582	419,808	237,227	34,039
6	214,080	492,232	0.8232	176,237	405,220	228,983	263,022
7	214,080	492,232	0.7946	170,113	391,139	221,026	484,049
8	214,080	492,232	0.7670	164,202	377,548	213,346	697,394
9	214,080	492,232	0.7404	158,496	364,428	205,932	903,327
10	214,080	492,232	0.7146	152,988	351,765	198,776	1,102,103
Total	2,444,816	3,937,857		2,093,306	3,195,409	1,102,103	

IDiscounted values (based on the present value of future costs and benefits) are used to provide a common unit of measurement to compare costs and benefits.

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Four alternatives considered for developing, operating, and maintaining the system. The alternatives and their estimated present value costs for the 10-year system life cycle are:

• contractor development and contractor operation	\$2,282,629
• contractor development and in-house operation	\$2,304,678
• in-house development and in-house operation	\$2,115,354
• in-house development and contractor operation	\$2,093,306

It was assumed that the system benefits would be the same for all four alternatives. The costs for the lowest-cost alternative were compared to the value of the benefits as shown in the table above. The comparison demonstrated that the benefits would exceed the costs.

1 INTRODUCTION

This section explains the purpose of this analysis, includes information about the Department of Health (DOH) investment review process, and provides background information on the Agency for Health Research.

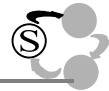
1.1 PURPOSE

This Cost-Benefit analysis was performed to satisfy a requirement of the DOH Information Technology Investment Review Process (ITIRP). This analysis will demonstrate that several alternatives for development and implementation were considered, and the alternative most beneficial to the Federal government was selected. It also demonstrates that the projected benefits will justify the costs of the system.

1.2 DOH INVESTMENT REVIEW PROCESS

The DOH Chief Information Officer (CIO) established an ITIRP to review and manage Operating Component (OPCOM) IT projects that have a direct impact on achieving the major missions of the Department. The Department required each OPCOM to develop their own investment review process, and the Agency for Health Research (AHR) recently began implementation of their ITIRP. Both ITIRPs were designed to comply with the requirements of the Information Technology Management Reform Act (ITMRA) of 1996, now referred to as the Clinger-Cohen Act.

One of the key components of the AHR ITIRP is the Information Technology Investment Review Board (ITIRB). The Board reviews all IT projects that affect more than one Bureau of the Agency, are critical to the mission of the Agency, require review at the Department level or Office of Management and Budget (OMB), or have high visibility to the public, the press or Congress. The Board reviews all new IT projects before any funds are budgeted for the project. The initial review is performed during the planning stages of a project, and a decision to proceed with the project is based on an analysis of a report of a proposed project with preliminary estimates of costs, benefits, performance measures, and schedules for development

**APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)**

and implementation. The project was subjected to a Conceptual Review¹, and directed to proceed to the next step, performing a Cost-Benefit Analysis (CBA). When the CBA is completed, there will be a review by the Technical Review Committee (TRC) of the ITIRB. If the CBA is approved by the TRC, the ITIRB will do a final review of the project, based on the CBA.

1.3 AHR BACKGROUND

The AHR became a component of the DOH when that Department was created in 1993. The AHR was originally a component of the Department of Defense, and became part of the Department of Health, Education, and Welfare in the 1950s. The AHR has been a leader in health research for many years. It conducts health research at its own facilities and awards grants to many organizations to conduct a variety of health research projects. The AHR has several Bureaus that conduct research in specific areas of health. The Office of the Director provides general management support services to all of the Bureaus. Research projects are conducted by grantees all over the world. The AHR has an annual budget of about \$10 billion, and employs more than 10,000 civilian employees in various locations throughout the United States. The majority of the funds are paid to grantees, and the majority of the AHR employees are located in the Baltimore-Washington metropolitan area.

1.4 METHODOLOGY

The methodology for this analysis is based on the Cost-Benefit Analysis Guide for NIH IT Projects. That document can be accessed at the following URL: <http://irm.cit.nih.gov/itmra/cbaguide.html>. In keeping with that guidance, the analysis was performed by a team of individuals specifically selected for their expertise in areas pertinent to this analysis. Appendix A contains a list of the team members and their relevant experience.

2 PROJECT OBJECTIVES

The basic objective of this project is to develop an automated Health Research Management Evaluation System (HRMES) that provides health research managers with an administrative information system that allows them to generate reports showing the status of the organization and evaluates the effectiveness of the managers. By using performance measures that quantify progress toward accomplishing the organization's mission, the system will not only report the status of an organization in terms of dollars spent, projects completed, and personnel utilization; it will provide a quantitative evaluation of the success in achieving goals and objectives that support the mission of the organization.

3 CURRENT PROCESS

¹ The Conceptual Review submission addressed the issue of whether or not the Government should be doing this, should some other agency do it, and should it be contracted out. The preliminary report on the proposed system is available at S:\STUDIES\MGMT\mgmteval.wpd.

**APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)**

The AHR managers currently use reports from systems operated at the DOH, AHR and the Bureau levels. These IT systems provide managers with a variety of reports on many different aspects of their organization, but none of them have information that can be related to indicators that measure performance of progress toward mission goals and objectives. The fact that we spent 99.99% of all appropriated funds and completed 1,000 research projects does not give us any idea whether or not the money spent and the efforts expended provide any benefits to the federal taxpayers. Compliance with the Government Performance and Results Act (GPRA) is currently being accomplished by manually comparing actual accomplishments against predetermined measures of accomplishment. This requires a significant amount of high level staff resources.

3.1 DOH SYSTEMS

The Department currently operates the DOH Payroll & Personnel System (PPS) and Grants Payment System (GPS). These systems are operated at the Department level because all of its components have payroll and personnel information processing requirements, and many components pay grantees to perform activities necessary to perform their mission. The PPS has evolved from a mainframe, COBOL, batch processing system with punch card inputs to a web-based system with on-line data entry and central processing in an ORACLE environment. The GPS is still a mainframe COBOL system with inputs from several other IT systems within the Department. It also receives inputs from other Federal Agencies and makes payments to their grantees.

3.2 AHR SYSTEMS

The following systems are operated at the AHR level by various components of the Office of the Director:

- The AHR Accounting System
- The AHR Budget System
- The AHR Property Management System
- The AHR Grants Management System
- The AHR Procurement Data System

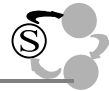
The systems listed above represent a variety of architectures and user interfaces. Specific information related to these systems is located at the AHR Chief Information Officer web site. The URL is <http://CIO.AHR.DOH.GOV>².

3.3 AHR BUREAU SYSTEMS

Each Bureau has at least one system that contains information that is unique to its operation. Information relation to the design and operation of the systems managed by the eight Bureaus is included in the document titled AHR Bureau Management Systems, and can be accessed at S:\IT\SYSTEMS\DOC. The files associated with specific systems are either WordPerfect or Word files. Very few of the systems have the same architectures or user interfaces.

3.4 SYSTEM UTILIZATION

² Do not try to locate this URL or other documents, they do not exist.

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The systems identified above are used in different ways by managers in each of the Bureaus and the OD. None of the managers interviewed used reports from all of the DOH and AHR systems³. Each manager had his/her own criteria for determining if they were satisfied with performance of their organization in specific areas such as budget, personnel, grants, etc. Although managers have written performance measures for those areas, none of the systems produced reports that related actual performance to goals and objectives of the Bureau and the Agency.

3.5 MANUAL INTERVENTION

Comparison of actual accomplishments and outcomes to goals and objectives is achieved by staff personnel that monitor and record performance measures for accomplishments and outcomes that are not maintained in any automated systems. Performance measures that are maintained in automated systems are manually combined with the other performance measures, and then compared with goals and objectives. Reports that evaluate and grade the various programs within the Bureaus are generated every month. Each Bureau uses one full-time person to maintain and monitor the performance measures and prepare the reports.

4 SYSTEM REQUIREMENTS

To meet the specified objectives for this project, the general requirements for the new system are:

- Provide an automated system that evaluates organizational performance in relation to mission goals, objects, results and outcomes
- Utilize outputs from existing systems to provide performance data
- Provide a web-based user interface
- Generate outputs that provide an objective evaluation of organizational performance
- Restrict access to authorized users
- Reduce manual monitoring and eliminate report preparation

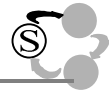
The requirements will be defined in much greater detail during the analysis and design phases of the project.

5 ALTERNATIVES

To develop a system to meet the specified requirements, there are many alternatives to be considered. Some of the alternatives considered were:

- in-house development and in-house operation
- in-house development and contractor operation
- contractor development and in-house operation

³ Over half of the top level managers in the Bureaus were interviewed during the preliminary study. The preliminary study addressed the use of current IT systems and the attitudes of managers toward a management evaluation system. The report can be accessed at S:\STUDIES\MGMT\mgmteval.wpd.

**APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)**

- contractor development and contractor operation
- mainframe architecture
- client-server architecture
- Commercial off the shelf (COTS) software
- Custom software

The first four alternatives reflect the combinations of the use of in-house resources versus contractors. The option of using mainframe architecture does not fit into the IT architecture for the AHR⁴, so it was not considered a viable option. There is no commercial software package that would accept inputs from the existing DOH and AHR systems that will provide input to the new system, so custom software would have to be used. It should be noted that continuation of the same mode of operation would not be an acceptable alternative because it does not provide an automated system to perform the evaluation.

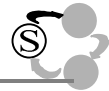
The four alternatives included this analysis assume the use of client-server architecture with custom software with development and operation being done with in-house resources or contractor resources as shown below:

- contractor development, contractor operation, client-server architecture, custom software
- contractor development, in-house operation, client-server architecture, custom software
- in-house development, in-house operation, client-server architecture, custom software
- in-house development, contractor operation, client-server architecture, custom software

6 DEVELOP COST ESTIMATES

Cost estimates are included here for each of the four alternatives. The first step in developing the estimates is to identify and estimating the time required to perform the major activities. The next step is to identify all costs associated with each activity. The final step is to total the costs for the life cycle of the system.

⁴ A description of the IT architecture is available at <http://CIO.AHR.DOH.GOV>.



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

6.1 ESTIMATE PERSONNEL COSTS⁵

The key factor in the development and implementation on an IT system is often the amount of time required for personnel to perform crucial activities. Those activities are identified as follows:

- Define Requirements
- Design New System
- Develop New System
- Install New System
- Operate New System

The estimated times and costs for the activities are based on the projected hours needed by five different types of personnel over a six-month period. The hourly rates for contractor personnel were based on the hourly rates of a large firm for a Federal government agency contract. The hourly rates for Government (in-house) personnel were based on the fully burdened rate for step 5 of the General Schedule (GS) grade levels, as shown below:

Fringe Benefits Factor (FBF) = 0.3245

Overhead Rate (OR) = 0.12

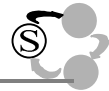
GS Level (Step 5)	Annual Salary* (AS)	Annual Fringe AS*FBF	Annual Overhead (AS+FBF)*OR	Burdened Cost (BC)**	Hourly Cost BC/2087
5	25,168	8,167.02	4,000.20	37,335.22	17.89
6	28,055	9,103.85	4,459.06	41,617.91	19.94
7	31,176	10,116.61	4,955.11	46,247.73	22.16
8	34,525	11,203.36	5,487.40	51,215.77	24.54
9	38,137	12,375.46	6,061.49	56,573.95	27.11
10	41,997	13,628.03	6,675.00	62,300.03	29.85
11	46,142	14,973.08	7,333.81	68,448.89	32.80
12	55,303	17,945.82	8,789.86	82,038.68	39.31
13	65,763	21,340.09	10,452.37	97,555.46	46.74
14	77,713	25,217.87	12,351.70	115,282.57	55.24
15	91,410	29,662.54	14,528.71	135,601.25	64.97

* Rates are for the Washington-Baltimore Area, 1999.

**The general formula for the total/fully burdened annual cost would be:
Direct Annual Salary x 1.48344 (the 1.48344 is equal to 1.3245 x 1.12).

The following estimates were based on projections from five different individuals with experience in developing systems in similar circumstances. Their projections were

⁵ Details on personnel costs can be found in the **OMB Circular A-76 Supplemental Handbook, PART II--Preparing the Cost Comparison Estimates**. Personnel Costs are also explained in the *Cost-Benefit Analysis Guide for NIH IT Projects*, Section 4.7.3. It explains the Fringe Benefits Factor and the Overhead Rate.

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based on a breakdown of each activity into sub-activities or tasks, with the breakdown of hours on a weekly basis.

Activity: Define Requirements

ContractorPersonnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Project Manager	110.00	160	160	160	100	60	20	660	72,600
Sr. Analyst	90.00	160	160	160	50			530	47,700
Jr. Analyst	30.00	160	160	120	24			464	13,920
Sr. Programmer	50.00	16	16	16	16			64	3,200
Data Base Analyst	45.00	16	16	16	16			64	2,880
Totals								1,782	140,300

Activity: Define Requirements

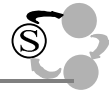
Government Personnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Project Manager	64.97	160	160	160	100	60	20	660	42,883
Sr. Analyst	55.24	160	160	160	50			530	29,276
Jr. Analyst	32.80	160	160	120	24			464	15,218
Sr. Programmer	39.31	16	16	16	16			64	2,516
Data Base Analyst	46.74	16	16	16	16			64	2,992
Totals								1,782	92,885

Activity: Design New System

ContractorPersonnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Project Manager	110.00	160	160	160	100	60	40	680	74,800
Sr. Analyst	90.00	160	160	160	100	60	40	680	61,200
Jr. Analyst	30.00	160	160	120	100	60	40	640	19,200
Sr. Programmer	50.00	160	160	160	100	60	40	680	34,000
Data Base Analyst	45.00	160	160	160	100	60	40	680	30,600
Totals								3,360	219,800

Activity: Design New System

Government Personnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Project Manager	64.97	160	160	160	100	60	40	680	44,182
Sr. Analyst	55.24	160	160	160	100	60	40	680	37,562
Jr. Analyst	32.80	160	160	120	100	60	40	640	20,991
Sr. Programmer	39.31	160	160	160	100	60	40	680	26,730
Data Base Analyst	46.74	160	160	160	100	60	40	680	31,786
Totals								3,360	161,252



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

Activity: Develop New System

ContractorPersonnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Project Manager	110.00	160	160	160	160	160	160	960	105,600
Sr. Analyst	90.00	160	160	160	160	160	160	960	86,400
Jr. Programmer	30.00	160	160	160	160	160	160	960	28,800
Sr. Programmer	50.00	160	160	160	160	160	160	960	48,000
Data Base Analyst	45.00	160	160	160	160	160	160	960	43,200
Totals								4,800	312,000

Activity: Develop New System

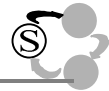
Government Personnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Project Manager	64.97	160	160	160	160	160	160	960	62,375
Sr. Analyst	55.24	160	160	160	160	160	160	960	53,029
Jr. Programmer	32.80	160	160	160	160	160	160	960	31,486
Sr. Programmer	39.31	160	160	160	160	160	160	960	37,737
Data Base Analyst	46.74	160	160	160	160	160	160	960	44,875
Totals								4,800	229,502

Activity: Install New System

ContractorPersonnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Operations Manager	43.00	160	160	120	100	80	40	660	28,380
System Administrator	37.00	160	160	160	160	160	160	960	35,520
Sr. Analyst	90.00	160	160	120	80	60	20	600	54,000
Sr. Programmer	50.00	160	160	120	100	80	80	700	35,000
Data Base Analyst	45.00	160	160	120	80	60	20	600	27,000
Totals								3,520	179,900

Activity: Install New System

Government Personnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Operations Manager	55.24	160	160	120	100	80	40	660	36,457
System Administrator	46.74	160	160	160	160	160	160	960	44,875
Sr. Analyst	55.24	160	160	120	80	60	20	600	33,143
Sr. Programmer	39.31	160	160	120	100	80	80	700	27,517
Data Base Analyst	46.74	160	160	120	80	60	20	600	28,047
Totals								3,520	170,038



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

Activity: Operate New System

Contractor Personnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Operations Manager	43.00	40	40	40	40	40	40	240	10,320
System Administrator	37.00	160	160	160	160	160	160	960	35,520
Sr. Analyst	90.00	20	20	20	20	20	20	120	10,800
Sr. Programmer	50.00	80	80	80	80	80	80	480	24,000
Data Base Analyst	45.00	20	20	20	20	20	20	120	5,400
Totals								1,920	86,040

Activity: Operate New System

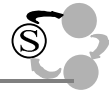
Government Personnel	Month	1	2	3	4	5	6	Total -	Total -
	Hrly Rate	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Cost
Operations Manager	55.24	40	40	40	40	40	40	240	13,257
System Administrator	46.74	160	160	160	160	160	160	960	44,875
Sr. Analyst	55.24	20	20	20	20	20	20	120	6,629
Sr. Programmer	39.31	80	80	80	80	80	80	480	18,869
Data Base Analyst	46.74	20	20	20	20	20	20	120	5,609
Totals								1,920	89,238

6.2 ESTIMATE TOTAL ACTIVITY COSTS

Although personnel costs are important, there are many other costs involved in the activities required for implementing a new system. The following tables show all of the costs associated with the five activities.

Activity: Define Requirements

Cost Category	Description	Contractor Cost	Government Cost
1. Equipment			
A. Capital Purchases			
B. Other Equipment			
Purchases/Leases			
2. Software			
A. Capital Purchases			
B. Other Software			
Purchases/Leases			
3. Services			
4. Support Services	Define Requirements	140,300	
5. Supplies		5,000	5,000
6. Personnel	Government Workers		92,885
7. Intra-govt Payments			
8. Intra-govt Collections			
Total Costs		145,300	97,885



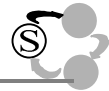
APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

Activity: Design New System

Cost Category	Description	Contractor Cost	Government Cost
1. Equipment			
A. Capital Purchases			
B. Other Equipment Purchases/Leases			
2. Software			
A. Capital Purchases			
B. Other Software Purchases/Leases			
3. Services			
4. Support Services	Design System	219,800	
5. Supplies		5,000	5,000
6. Personnel	Government Workers		161,252
7. Intra-govt Payments	Internal Computer Use	6,000	6,000
8. Intra-govt Collections			
Total Costs		230,800	172,252

Activity: Develop New System

Cost Category	Description	Contractor Cost	Government Cost
1. Equipment			
A. Capital Purchases	New Server	30,000	25,500
B. Other Equipment Purchases/Leases	Cable, monitors, printers, etc.	10,000	8,500
2. Software			
A. Capital Purchases	Network Operating System & Data Base Software	10,000	8,500
B. Other Software Purchases/Leases			
3. Services			
4. Support Services	Develop New System	312,000	10,000
5. Supplies		5,000	5,000
6. Personnel	Government Workers		229,502
7. Intra-govt Payments			
8. Intra-govt Collections			
Total Costs		367,000	287,002



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

Activity: Install New System

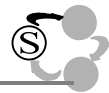
Cost Category	Description	Contractor Cost	Government Cost
1. Equipment			
A. Capital Purchases			
B. Other Equipment Purchases/Leases			
2. Software			
A. Capital Purchases			
B. Other Software Purchases/Leases			
3. Services			
4. Support Services	Install New System	179,900	
5. Supplies		5,000	5,000
6. Personnel	Government Workers		170,038
7. Intra-govt Payments			
8. Intra-govt Collections			
Total Costs		184,900	175,038

Activity: Operate New System

Cost Category	Description	Contractor Cost	Government Cost
1. Equipment			
A. Capital Purchases			
B. Other Equipment Purchases/Leases	Cable, monitors, printers, etc.	5,000	4,250
2. Software			
A. Capital Purchases			
B. Other Software Purchases/Leases	Software Upgrades	5,000	4,250
3. Services			
4. Support Services	Operate and Maintain	86,040	
5. Supplies		5,000	5,000
6. Personnel	Government Workers		89,238
7. Intra-govt Payments	Equipment Maintenance	6,000	6,000
8. Intra-govt Collections			
Total Costs		107,040	108,738

6.3 COMPUTE LIFE CYCLE COSTS

The life cycle costs for a system cover all of the activities included in the previous section. It includes the development and implementation of a system and the operation and maintenance of the system until it is terminated or replaced by another system. The costs addressed for the individual activities all cover periods of six months. The last activity, Operate New System, includes both operations and maintenance for the system. Since the life cycle of the system is 10 years, and the development and installation requires two years, the system will be in full operation and maintenance mode for eight years. The annual cost of operations and maintenance is calculated by multiplying the six-month cost by two.

**APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)****6.3.1 Life Cycle Costs - Alternative 1**

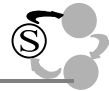
The life cycle costs for Alternative 1, Contractor Development and Operation, were generated by taking the estimated contractor costs for all five activities and including them in the appropriate year of the system life cycle. Costs for each year and the total cost are shown below.

Year	Define Requirements	Design	Develop	Install	Operate Maintain	Total
1	145,300	230,800				376,100
2			367,000	184,900		551,900
3					214,080	214,080
4					214,080	214,080
5					214,080	214,080
6					214,080	214,080
7					214,080	214,080
8					214,080	214,080
9					214,080	214,080
10					214,080	214,080
Total	145,300	230,800	367,000	184,900	1,712,640	2,640,640

6.3.2 Life Cycle Costs - Alternative 2

The life cycle costs for Alternative 2, Contractor Development and Government Operation, were generated by taking the estimated contractor costs for Define Requirements, Design New System, Develop New System, and Install New System and the government costs for Operate and Maintain, and including them in the appropriate year of the system life cycle. Costs for each year and the total cost are shown below.

Year	Define Requirements	Design	Develop	Install	Operate Maintain	Total
1	145,300	230,800				376,100
2			367,000	184,900		551,900
3					217,476	217,476
4					217,476	217,476
5					217,476	217,476
6					217,476	217,476
7					217,476	217,476
8					217,476	217,476
9					217,476	217,476
10					217,476	217,476
Total	145,300	230,800	367,000	184,900	1,739,812	2,667,812



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

6.3.3 Life Cycle Costs - Alternative 3

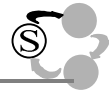
The life cycle costs for Alternative 3, Government Development and Government Operation, were generated by taking the estimated government costs for all activities, and including them in the appropriate year of the system life cycle. Costs for each year and the total cost are shown below.

Year	Define Requirements	Design	Develop	Install	Operate Maintain	Total
1	97,885	172,252				270,137
2			287,002	175,038		462,040
3					217,476	217,476
4					217,476	217,476
5					217,476	217,476
6					217,476	217,476
7					217,476	217,476
8					217,476	217,476
9					217,476	217,476
10					217,476	217,476
Total	97,885	172,252	287,002	175,038	1,739,812	2,471,988

6.3.4 Life Cycle Costs - Alternative 4

The life cycle costs for Alternative 4, Government Development and Contractor Operation, were generated by taking the estimated government costs for Define Requirements, Design New System, Develop New System, and Install New System and the contractor costs for Operate and Maintain, and including them in the appropriate year of the system life cycle. Costs for each year and the total cost are shown below.

Year	Define Requirements	Design	Develop	Install	Operate Maintain	Total
1	97,885	172,252				270,137
2			287,002	175,038		462,040
3					214,080	214,080
4					214,080	214,080
5					214,080	214,080
6					214,080	214,080
7					214,080	214,080
8					214,080	214,080
9					214,080	214,080
10					214,080	214,080
Total	97,885	172,252	287,002	175,038	1,712,640	2,444,816



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

7 DISCOUNT & COMPARE COSTS

The life cycle costs for each alternative must be compared to determine the most cost-effective alternative. The table below illustrates the life cycle costs for each of the four alternatives. Alternative 4, Government Development and Contractor Operation, has the lowest cost; however, the next lowest cost alternative is only about 1% higher.

Year	Alternative 1 CD/CO	Alternative 2 CD/GO	Alternative 3 GD/GO	Alternative 4 GD/CO
1	376,100	376,100	270,137	270,137
2	551,900	551,900	462,040	462,040
3	214,080	217,476	217,476	214,080
4	214,080	217,476	217,476	214,080
5	214,080	217,476	217,476	214,080
6	214,080	217,476	217,476	214,080
7	214,080	217,476	217,476	214,080
8	214,080	217,476	217,476	214,080
9	214,080	217,476	217,476	214,080
10	214,080	217,476	217,476	214,080
Total	2,640,640	2,667,812	2,471,988	2,444,816

The table below illustrates the life cycle costs of the four alternatives after they have been discounted. The present value (also referred to as the discounted value) of a future amount is calculated with the following formula:

$$P = F (1/(1+I)^n)$$

Where P = Present Value,

F = Future Value,

I = Interest Rate, and

n = number of years.

The term Discount Factor is used for $1/(1+I)^n$. Present values can be calculated by multiplying the future value times the Discount Factor instead of using the entire formula. The formula $1/(1+I)^n$ is used when the assumption is that costs and benefits occur as lump sums at year-end. The formula for the midyear Discount Factor is $1/(1+I)^{n-0.5}$. Midyear discount factors are used when the money is dispensed fairly evenly throughout the year.

The interest rate is published in Appendix C of OMB Circular A-94, (URL = <http://www.whitehouse.gov/WH/EOP/OMB/html/circulars/a094/a094.html#ap-c>). The Real Interest Rates on Treasury Notes and Bonds for 1998 for a 10-year period was 3.6%, so the interest rate used for the calculations was .036. Mid-year discount factors were used.



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

Year	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Discount Factor
1	369,508	369,508	265,402	265,402	0.9825
2	523,384	523,384	438,167	438,167	0.9483
3	195,964	199,073	199,073	195,964	0.9154
4	189,155	192,156	192,156	189,155	0.8836
5	182,582	185,478	185,478	182,582	0.8529
6	176,237	179,033	179,033	176,237	0.8232
7	170,113	172,812	172,812	170,113	0.7946
8	164,202	166,807	166,807	164,202	0.7670
9	158,496	161,011	161,011	158,496	0.7404
10	152,988	155,416	155,416	152,988	0.7146
Total	2,282,629	2,304,678	2,115,354	2,093,306	

Alternative 4 is still the lowest cost alternative; however, Alternative 3 is still so close (it is only 1% more than Alternative 4) that it could be selected as the best alternative if there were other non-monetary factors that favored Alternative 3. It should be noted that the difference between the highest and lowest cost alternatives is only \$211,372, which is about 10% of \$2,093,306 estimated for the lowest alternative. Since the accuracy of these estimates could easily be off by 10% -20%, any of the alternatives could be selected if there were other non-monetary considerations that favored one of the alternatives.

For this sample, the lowest cost alternative (#4) was selected as the best alternative. In some environments, technical risk, ability to meet implementation objective dates, and time required to put a contract in place are other factors that might be used to determine the best alternative. In any environment, availability and experience of in-house personnel and the availability of contract funds should be considerations that could easily outweigh the importance of the minor cost differences.

8 BENEFITS

The primary projected benefit of the proposed system is the cost avoidance of the salaries of the staff personnel currently doing this effort. Secondary benefits will be the speed and accuracy of the reports. The automated system will provide the evaluation reports the first day of the new month rather than a week or 10 days into the month. The accuracy will improve because the many of the manual errors that currently occur will be eliminated. The primary benefit is fairly easy to quantify; it is the current cost to government of the personnel producing the reports. The preliminary study showed that the average grade of the people in the eight Bureaus was a GS-12. The study also indicated that about 25% of a person's time would still be required to enter performance data and goals and objectives. We therefore estimate that 75% of the time for each of the people in the Bureaus will be available for other duties, the annual cost avoidance in



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

each Bureau will be equal to 75% of the annual cost of a GS1-12. The salary table on page 6 shows that the annual burdened for a GS-12 in the Washington-Baltimore Area is \$82,038.68 for 1999. Multiplying that by .75 gives the annual savings for each person, and multiplying by 8 gives the annual cost avoidance as demonstrated below.

Annual Burdened Cost (BC) AS+AF+AO	Cost Avoidance Factor CA	# of Workers NW	Annual Cost Avoidance BCxCAxNW
82,038.68	0.75	8	492,232

The value of increased accuracy and more timely creation of the reports is difficult to determine. Since the benefits addressed above are significantly greater than the costs, no attempt was made to place a dollar value, or even a relative value on those benefits.

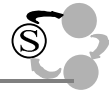
9 COMPARE BENEFITS AND COSTS

The table below illustrates the total costs and total benefits from FY 1999 through FY 2006. The costs are discounted on the assumption that costs are incurred and benefits accrue throughout each year. The Discounted Cost for each year is computed by multiplying the Annual Cost by the Discount Factor. The Discounted Benefit for each year is computed in the same manner, by multiplying the Annual Benefit by the Discount factor. Subtracting the Discounted Cost from the Discounted Benefit gives the Discounted Net for each year.

The Discounted Net is negative for the first two years when the system is being developed. Once the system is operational, the Discounted Net becomes positive. The Cumulative Discounted Net is negative for the first four years, which means that the money invested in the development, installation and operation of the system is not offset by the benefits until after the 4th year. In other words, the payback period for the system is five years.

Year	Annual Cost AC	Annual Benefit AB	Discount Factor DF	Discounted Cost (DC) ACxDF	Discounted Benefit (DB) AbxDF	Discounted Net DB-DC	Cumulative Discounted Net
1	270,137		0.9825	265,402	0	(265,402)	(265,402)
2	462,040		0.9483	438,167	0	(438,167)	(703,569)
3	214,080	492,232	0.9154	195,964	450,579	254,614	(448,954)
4	214,080	492,232	0.8836	189,155	434,921	245,767	(203,188)
5	214,080	492,232	0.8529	182,582	419,808	237,227	34,039
6	214,080	492,232	0.8232	176,237	405,220	228,983	263,022
7	214,080	492,232	0.7946	170,113	391,139	221,026	484,049
8	214,080	492,232	0.7670	164,202	377,548	213,346	697,394
9	214,080	492,232	0.7404	158,496	364,428	205,932	903,327
10	214,080	492,232	0.7146	152,988	351,765	198,776	1,102,103
Total	2,444,816	3,937,857		2,093,306	3,195,409	1,102,103	

The Total Discounted Benefits exceed the Total Discounted Costs; therefore, the investment is cost-effective. The Total Discounted Net (Total Discounted Benefits minus the Total Discounted Costs) is often referred to as the profit or return on the

**APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)**

investment. Another way of looking at the investment is to consider the cost in relation to the “profit” or return. In this case, the Discounted Cost is \$2,093,306, and the Discounted Net is \$1,102,103. The Discounted Net divided by the Discounted Cost equals 0.53; therefore, the return on investment (ROI) rate would be 53% (multiplying the number by 100 converts the decimal to a percentage).

The numbers clearly indicate that the system should be developed and implemented; however, it should be noted that in some organizations, this project may be competing with other projects for available funds. If that is the case, the payback period and the rate of return on the investment become very important in the investment review process, and this project may not get funded if other proposed projects look like they will provide a greater return on the funds available, or the payback period is less for other projects.

10 SENSITIVITY ANALYSIS

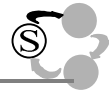
Sensitivity analysis tests the impact of changes in input parameters on the results obtained from the benefit-cost analysis. For example, how much change in the value of the benefits is required before the costs of the proposed system exceed the benefits. If we assume that the new system will only save .5 of the time of the staff personnel, instead of .75, the annual savings/cost avoidance drops from \$492,232 to \$328,155. With that scenario, the discounted net is only \$36,967 after 10 years. The payback period increases from 5 years to 10 years, and the return on investment (ROI) drops from 53% to 3%, but the benefits still exceed the costs⁶. If we assume that the new system will only save .45 of the time of the staff personnel, the annual savings/cost avoidance drops to \$295,339. The discounted net is then a negative \$176,060 after 10 years. The payback period increases beyond the 10 year life cycle, and the ROI becomes a negative 8% because the benefits do not exceed the costs.

The conclusion here is that the amount of time saved for the staff personnel is crucial to justifying the system, but it is not a highly sensitive parameter. It required a decrease of one third (from .75 to .50) of the original number to get to the point where benefits barely exceeded the costs.

Another example would be how much would the hourly rates for contractors have to change to affect the lowest cost option for developing and operating the system. Contractors often can be flexible with their rates if they are really eager to develop a particular system. Decreasing the salary rates for the contractors by 10%⁷ reduces the discounted costs from \$2,093,306 to \$1,981,597. Alternative 4, Government Development and Contractor Operation, is still the lowest cost alternative, and the Discounted Net increases from \$1,102,103 to \$1,213,812, which causes the return on investment rate to increase from 53% to 61%. Decreasing the salary rates for the contractors by 20% reduces the discounted costs \$1,869,888. Alternative 4 is still the

⁶ These comparisons can be accomplished by changing the .75 in cell B8 of the Benefits worksheet of the spreadsheet cbasample2.xls to .50 and .45.

⁷ These changes can be done, temporarily, by multiplying (the original values in cells H11 through H18 in the Rates worksheet in the cbasample2.xls spreadsheet) by .9.



APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)

lowest cost alternative, and the Discounted Net increases to \$1,325,521, which causes the return on investment rate to increase to 71%.

If we increase the salary rates for the contractors by 10%, it increases the discounted costs from \$2,093,306 to \$2,115,354. Alternative 3, Government Development and Government Operation, becomes the lowest cost alternative, and the Discounted Net decreases from \$1,102,103 to \$1,080,055, which causes the return on investment rate to decrease from 53% to 51%. If we increase the salary rates for the contractors by more than 10%, Alternative 3 again becomes the lowest cost alternative, so the benefit-cost comparison will be the same as it was for a 10%

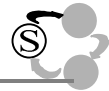
The conclusion is that, although contractor labor rates are important in the analysis, they are not critical, sensitive factors. If contractor rates increase, government personnel will be used for both development and operations. If contractor rates decrease, the return on investment increases, and the payback period will be reduced.

The same type of analysis could be done on the government costs. Increasing the grade level of the various personnel could make the options using contractors be the lowest cost alternative. Another factor that is extremely important is the number of hours projected for the various activities. The key there is that no individual numbers have a great impact on the final results.

In summary, the number of factors affecting the costs is so large that no individual parameter is going to have a huge impact on the analysis. On the benefits side, the percentage of time that will be saved is a key fact in the analysis; however, it is not highly sensitive, and the number used is based on the preliminary study that was done during the feasibility phase of this project. As a result, the conclusion that proceeding with the implementation of the system appears to be based on good, reliable numbers.

A summary of the parameter changes that were tested, along with the results is provided below.

Parameters	Parameter Values	Discounted Benefits	Discounted Costs	Discounted Net	Return On Investment Rate	Best Alternative
Cost Avoidance Factor	0.75	3,195,409	2,093,306	1,102,103	53%	4
	0.50	2,130,272	2,093,306	36,966	2%	4
	0.45	2,024,599	2,093,306	-68,707	-3%	4
Contractor Labor Rates	Original Values	3,195,409	2,093,306	1,102,103	53%	4
	90% of Original	3,195,409	1,981,597	1,213,812	61%	4
	80% of Original	3,195,409	1,869,888	1,325,521	71%	4
	110% of Original	3,195,409	2,115,354	1,080,055	51%	3
	120% of Original	3,195,409	2,115,354	1,080,055	51%	3

**APPENDIX F-2 (COST BENEFIT ANALYSIS SAMPLE 2 CONTINUED)****Attachment A - Cost-Benefit Analysis Team****George Washington, Team Leader**

George has been with the Department of Health for seven years, and has 17 years of experience in information technology (IT). He has a Master of Science degree in Information Systems from Georgetown University, and received his Bachelor of Science degree in Computer Science from the University of Maryland. He has extensive experience in developing information systems in the Federal Government and the private sector. He has served successfully as a project manager on several large systems development effort. Some of his private sector experience included estimating costs for proposals for the development of IT systems for the Federal government. George is currently the Chief of the Information Resources Management Branch in the DOH Computer Center.

Patrick Henry, Computer Specialist

Patrick has been with the DOH since graduating from South Dakota State University with a B.S. in Mathematics, with a minor in Computer Science. He has been writing computer programs and designing data bases for the past eight years. He has experience with both mainframe and PC systems on a variety of platforms.

Margaret Thatcher, Program Analyst

Margaret has served as Special Assistant to the Director, NIH, for the past three years. Prior to this assignment, she spent several years as the Executive Officer of the National Institute of Clinical Research. Earlier in her career she served as a nurse in two large hospitals. In addition to her nursing degree, she has a Master's degree in Public Health from Yale University. Her primary responsibility with Dr. Varmus has been in the area of information systems and grants management.

Harriet Tubman, Computer Systems Analyst

Harriet has nearly 30 years of service with AHR, with a wide range of experience developing systems in both mainframe and client server environments. One of her primary responsibilities is reviewing and approving estimates and plans for the development of new systems by the AHR Computer Center. She is recognized as one of the top computer analysts in all of the Department of Health. She serves on a number of committees that require a high degree of technical expertise.

Alexander Hamilton, Economist

Alexander has Bachelors and Master's degree in Economics from Harvard University. He is employed by the AHR as a Special Assistant to the Director of the Office of Management for AHR. He has held a variety of management positions with private industry, and is currently employed as special expert with the Federal government. One of his current assignments is to champion the efforts to develop activity based accounting within the AHR to help determine the actual costs of administrative support functions, such as procurement, property management, human resources management, and information technology.

